

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
16 June 2005 (16.06.2005)

PCT

(10) International Publication Number
WO 2005/054738 A1

(51) International Patent Classification⁷: **F16L 55/28**,
55/128, 55/132, F15B 15/18

(21) International Application Number:
PCT/NO2004/000375

(22) International Filing Date: 6 December 2004 (06.12.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20035443 5 December 2003 (05.12.2003) NO

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

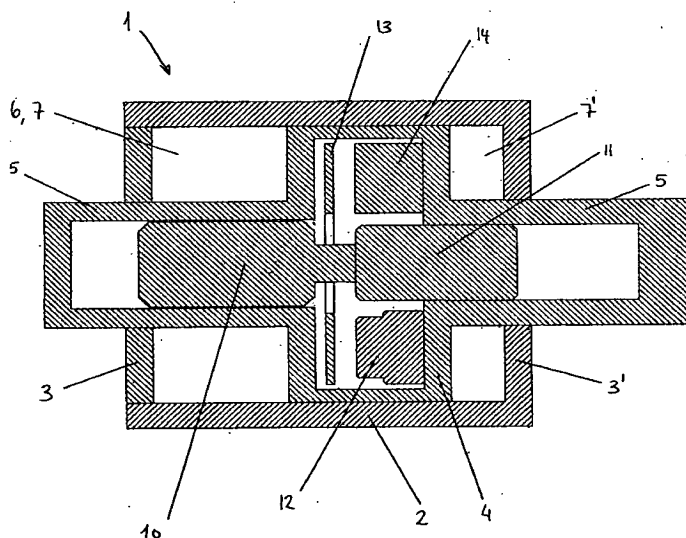
(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO,
SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:

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CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE,

[Continued on next page]

(54) Title: HYDRAULIC CYLINDERS AND PLUG WITH HYDRAULIC CYLINDER



(57) **Abstract:** The invention regards a hydraulic cylinder (1) or a plug comprising a hydraulic cylinder for operation of anchoring and/or sealing devices, where the hydraulic cylinder comprising a cylinder chamber (6), a piston head (4) within said cylinder chamber (6) forming two sub-chambers (7, 7') of said cylinder chamber (6) one on each side of the piston head (4), and a piston rod (5) which runs through the piston head (4) and said two sub-chambers (7, 7') or only one of said sub-chambers. The hydraulic power unit (8) for operation of the hydraulic cylinder (1) is situated at least partly within the parts forming the hydraulic cylinder (1) itself, preferably the piston head (4) and/or the piston rod (5).

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IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Hydraulic cylinders and plug with hydraulic cylinder

The present invention regards hydraulic cylinders and a plug with a hydraulic cylinder for sealing off a pipeline. By hydraulic cylinder it is in this patent application meant a cylinder with endplates, a piston head and piston rod, which piston head is moved within the cylinder by adding and or removing fluid from one or both sides of the piston head, and the piston rod is connected to the piston head.

When using a hydraulic cylinder there is a need for feeding pressurized fluid into one or both sides of the piston head. In the most commonly used pistons there is a piston rod running from one side of the piston head and out of the piston chamber wherein the piston head is situated. This creates the problem of different volumes on the two sides of the piston head and therefore the need for an accumulator tank for the hydraulic fluid to compensate for the differences in volumes on the two sides of the piston head when it is moved within the piston chamber. This tank for the hydraulic fluid and also control devised for operation of the hydraulic cylinder, as pumps, valves, transmitters etc. constitutes a need for additional space in addition to the hydraulic cylinder itself.

In NO application 20023100 there is described a piston in relation with a plug for closing off pipelines, where the piston rod runs through the piston head and the whole chamber, in other words through both sub chambers, one on each side of the piston head. This means equal volume changes on both sides of the piston head, when it is moved within the piston chamber. This solution eliminates or at least reduces the volume of an accumulator tank for the hydraulic fluid to a minimum.

However, both these solutions must normally be equipped with power units and control lines to the outside of the hydraulic piston for operation of the hydraulic cylinder and in the first example there also have to be an accumulation tank and fluid lines running into the hydraulic cylinder's chambers.

The lines for operation of the hydraulic cylinder hydraulic fluid lines and power lines etc. create several problems in use. In general it is a problem to get the connection between the lines and the hydraulic cylinder secure and there have to be several entries into the cylinder chamber to operate the piston. Further constitutes these lines and the other equipment for operating the hydraulic cylinder as a pump, circuit board, valves, batteries etc a need for additional space outside the hydraulic cylinder. When using a hydraulic cylinder in for instance a plug for closing off pipelines, the need for this additional space is a major drawback.

One object of the present invention is to provide a hydraulic cylinder which takes little space. With hydraulic cylinder it is as pervious stated meant a cylinder with endplates forming a cylinder chamber, a piston head within said chamber and a

piston rod running from said piston head and hydraulic fluid for operation of the hydraulic cylinder, and this phrase is used for the rest of the application.

5 It is another object of the present invention to provide a hydraulic cylinder which is reliable and needs less maintenance than prior art hydraulic cylinders. It is also an object to provide a hydraulic cylinder without external hydraulic fluid lines.

Another object of the present invention is to provide a plug which has a wider range of use than other plugs, and a plug which is shorter in length and therefore also may be used in pipelines with sharper bends. It is also an object of the present invention to provide a plug without hydraulic lines running outside the plug.

10 A hydraulic cylinder and a plug wherein the above mentioned objects is achieved and the aforementioned drawbacks with prior art is improved, is obtained with a plug and a hydraulic cylinder according to the claims.

15 A plug with a hydraulic cylinder or a hydraulic cylinder according to the present invention comprises a cylinder with two endplates forming a cylinder chamber, a piston head within said cylinder chamber forming two sub chambers of said cylinder chamber, one on each side of the piston head, and a piston rod. The piston rod runs in the preferred embodiment through both sub chambers of said hydraulic cylinder. In another embodiment the piston rod runs from the piston head through only one of said sub chambers. There is at least hydraulic fluid on one side of said
20 piston head in the cylinder chamber with fluid connections to a control system. The hydraulic cylinder is according to prior art equipped with sealing devices between movable parts, but these are not at part of the invention and will therefore not be explained further. A skilled person will be able to choose the appropriate and needed equipment to make the hydraulic cylinder work.

25 The hydraulic cylinder is operated by a control device, which controls a hydraulic power unit. In the present invention the control device and or the hydraulic power unit are situated at least partly within the parts forming the hydraulic cylinder itself.

By this is it meant that all or parts of the control devices and or hydraulic power unit may be situated in the cylinder, endplates, piston head and or piston rod.

30 There are several solutions which may be envisaged for placement of the different parts of the elements. A small accumulation tank for the hydraulic fluid may be placed in the cylinder wall and or an endplate. Another possibility is to have fluid lines, valves and pump situated within the piston head. Another possibility is to have fluid lines and valves in the piston head and motor and pump and possibly a
35 tank fully or partly within the piston rod. One may also envisage that the motor is partly situated within the piston rod with cable lines running from the piston rod

and to a battery pack outside the hydraulic cylinder or to an energy source outside the pipeline.

In an preferred embodiment of the invention the control device is operated remotely, and the remote controlling device and the hydraulic power unit, comprising at least motor, circuit board, valves, pressure transmitter, hydraulic pump, etc, for the hydraulic cylinder, is situated within the piston rod and or the piston head, where the larger elements as the motor and the hydraulic pump of the hydraulic power unit are positioned at least partly within the piston rod. The piston head comprises feed lines for hydraulic fluid from a first sub chamber, through said valves and said pump to a second sub chamber. By this one may operate the hydraulic cylinder by moving hydraulic fluid from one to the other sub chamber.

The hydraulic cylinder according to the invention may be a one-way or two-way operational hydraulic cylinder. The hydraulic cylinder may have a piston rod running through one or both of said sub chamber of the hydraulic cylinder. In a two way operational hydraulic cylinder is the hydraulic pump normally and preferably a two-way pump, instead of having two pumps which takes more space and the piston rod runs preferably through both sub-chambers to avoid the need for a large accumulation tank.

The preferred embodiment of the hydraulic cylinder gives a hydraulic cylinder which is small and with no externally running fluid lines. This means a hydraulic cylinder which is more reliable in that one has no danger of leakage in the connection of fluid lines to the hydraulic cylinder itself. However, one may envisage some control lines between the hydraulic cylinder and for instance an outside battery pack, especially in the case where the hydraulic cylinder is remotely operated.

The present invention also regards a plug for closing off a pipeline for a fluid flow. The plug comprises, as a normal plug, anchoring and sealing means for anchoring and sealing against the internal wall of the pipeline. These anchoring and sealing means may be an integrated unit or two different units with separate tasks and separate control device. However, the anchoring and sealing devices are operated by at least one hydraulic cylinder. There may be one hydraulic cylinder operating both anchoring and sealing devices and several hydraulic cylinders operating parts of the sealing or anchoring devices. The hydraulic cylinder according to the invention is operated by a hydraulic power unit and remote operation device which are situated at least partly within the hydraulic cylinder itself. There are here as mentioned above several possibilities which are within the scope of the invention as defined in the claims and which are within the range of a skilled person.

In a preferred embodiment the plug comprises anchoring and sealing devices operated by one common hydraulic cylinder, wherein the operation is achieved with

a hydraulic power unit partly within the hydraulic cylinder itself preferably in the piston head and piston rod. In the preferred embodiment is the plug remotely operated, which means remote operation devices within the hydraulic cylinder as well. The plug may be operated by direct control lines to the outside of the pipeline, but in normal operation of the plug according to the invention is it used in pipelines with a length which makes direct operation not possible, so remote operation is a necessity.

The present invention will now be explained with a preferred embodiment with references to the enclosed drawings, where:

Fig. 1 shows a preferred embodiment of a hydraulic cylinder according to the invention,

Fig. 2 shows an embodiment of a plug according to the invention.

The hydraulic cylinder 1 according to the invention comprises as shown in fig. 1 a cylinder 2 with two endplates 3, 3', which together forms a cylinder chamber 6, a piston head 4 and a piston rod 5. The cylinder 2 and one of the endplates 3' may as shown in the figure, be formed as one element. The hydraulic cylinder 1 has the piston head 4 within the cylinder chamber 6 and this forms two sub chambers 7, 7' one on each side of the piston head 4. The piston head 4 has according to the preferred embodiment as shown in the figures, a piston rod 5 running from the piston head 4 and out of the cylinder chamber 6, on both sides of the piston head 4, i.e. the piston rod runs through the whole cylinder chamber and out on both sides. The piston rod 5 and piston head 4 is in the preferred embodiment made in one piece. They may be formed by several elements.

As shown in fig. 1 the hydraulic power unit for operating the hydraulic cylinder is situated within the element forming the piston rod 5 and piston head 4. The power unit comprises a pump 11, a motor 10 running the pump 11, a circuit board 13, power transmitters 14 and valves 12. All these elements are schematically shown in fig. 1, and for instance fluid lines from one sub chamber through valves and pump to the other sub chamber is not shown for clarity. A skilled person will understand that there has to be one opening from one sub chamber 7 into the piston head 4 for a fluid line with closing valves 12 and pump 11 connected in this fluid line which runs to an opening in the piston head 4 facing the other sub chamber 7'. By running the pump 11 one or two ways the hydraulic cylinders piston head 4 may be moved one or two ways within the cylinder chamber 6.

As mentioned before the hydraulic cylinder may be of a kind without a through going piston rod 5. In that case must an accumulation tank for instance be placed at least partly within the hydraulic cylinder, to accumulate the difference in volume changes between the two different sub-chambers. The accumulation tank may also

according to the invention be placed outside the hydraulic cylinder, while other parts of the hydraulic power unit are inwards the hydraulic cylinder, but this is not favourable.

5 One may also envisage that the pump may be situated partly outside the piston rod and that the motor running the pump or a battery pack for a motor is outside the hydraulic cylinder, for instance at one end of the piston rod. This still gives the benefit of no external hydraulic lines for the hydraulic cylinder.

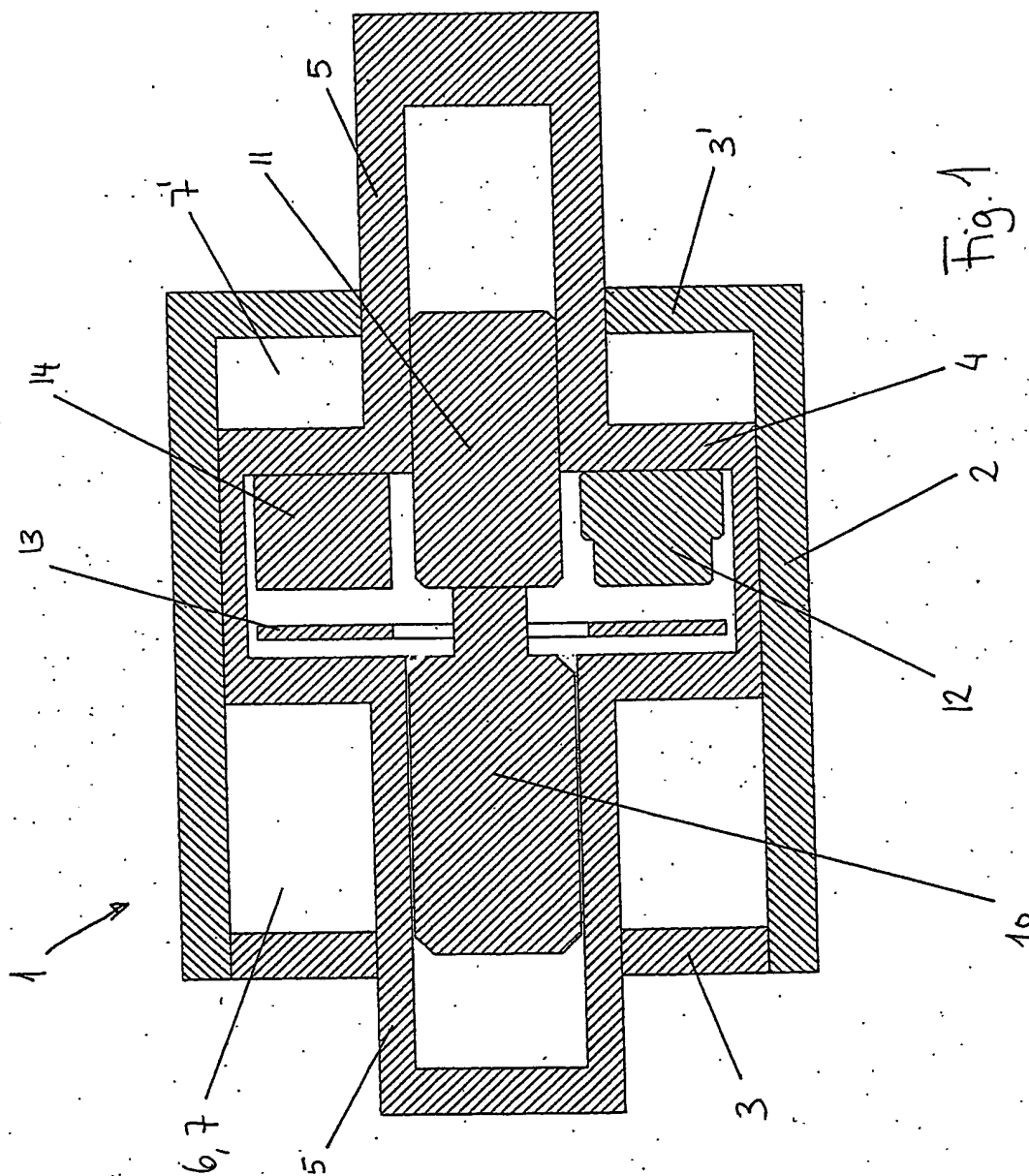
10 As shown in fig. 2, one use of the hydraulic cylinder 1 according to the invention, as described above, is in a plug 21. A plug 21 for closing off a pipeline 20 comprises anchoring means 24 and sealing means 25. The hydraulic cylinder 1 is used to operate the anchoring and sealing means and thereby set and or release the plug 21 in the pipeline 20. The plug may be actively operated by lines from an operation control outside the plug.

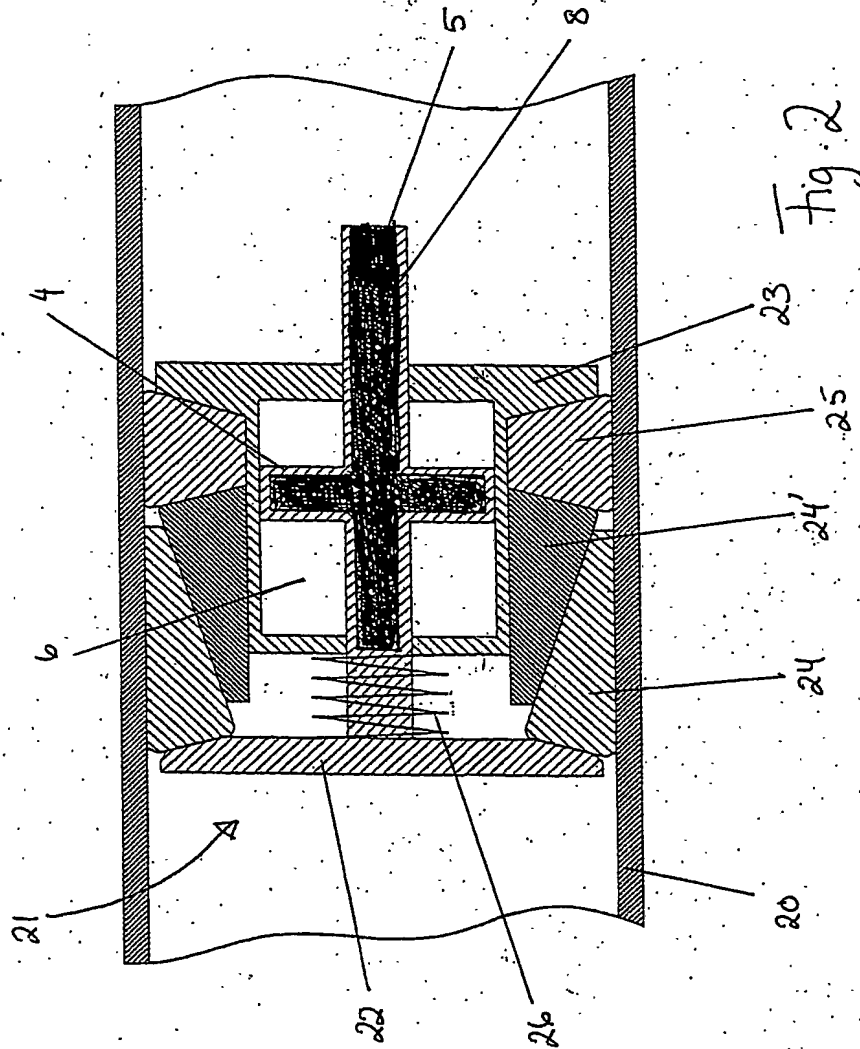
15 In a preferred embodiment comprises the plug 21 as shown in fig. 2, a first and second endplate, 22 and 23 respectively. There is in this preferred embodiment one hydraulic cylinder operating both anchoring means in form of a first and second wedge part 24, 24', and sealing means 25 in form of a packer. The first wedge 24 of the anchoring means is in abutment against the first endplate 22. The second wedge 24' is between the first wedge 24 and the hydraulic cylinder 1 and in abutment
20 against a packer 25 behind the anchoring means – seen from the first end plate 22. The packer 25 is situated between the second wedge part 24' and the second end plate 23 of the plug. The piston rod 5 is connected to the first end plate 22 and is a through going piston rod 5. The cylinder chamber 6 is situated centrally in the plug 21 with a longitudinal axis mainly corresponding with the longitudinal axis of the
25 pipeline 20. The wedges 24, 24' forming the anchoring means and packer 25 forming the sealing means is situated around the circumference of the hydraulic cylinder, in the annulus between the hydraulic cylinder and the pipeline 20. The second endplate 23 of the plug 21 forms as well one endplate of the cylinder chamber 6, and thereby connecting the cylinder chamber 6 of the hydraulic cylinder
30 to the second endplate 23 of the plug 21. The hydraulic cylinder in this embodiment is pre-stressed with a spring 26 between the cylinder chamber 6 and the first endplate 22 of the plug and will try to retract the plug's anchoring means unless hydraulic fluid is pressurized in the hydraulic cylinder. The hydraulic power unit 8 in this preferred embodiment is situated within the one element forming the piston
35 rod 5 and piston head 4. Batteries for running the motor in the hydraulic power unit 8 may be situated outside the plug 21 and connected to the end of the piston rod 5. In this preferred embodiment includes the hydraulic power unit 8 also remote controlling devices for remote control of the plug, from the outside of the pipeline.

The present invention has now been explained with preferred embodiments, but there are several changes and alterations which a skilled person may envisage within the scope of the invention as defined in the attached claims. The plug may be operated with two or more hydraulic cylinder, the hydraulic cylinder may not have a through going piston rod, the hydraulic cylinder in the plug may not be pre-stressed, and the placement of parts of the hydraulic power unit may be envisaged differently. The plug may be equipped with a lot of other equipment necessary for the use of the plug, as cutting devices, connection devices or other tools.

CLAIMS

1. Plug (21) for closing off a pipeline (20) for a fluid flow, comprising
anchoring (24) and sealing (25) means for anchoring and sealing against the
internal wall of the pipeline (20), which means are operated by at least one
5 hydraulic cylinder, which hydraulic cylinder comprises a cylinder with a
cylinder chamber (6), a piston head (4) situated within the cylinder chamber
(6) and dividing it in two sub chambers (7, 7') and a piston rod (5) which
runs through the piston head (4) and through at least one of the sub chambers
(7, 7'), wherein the hydraulic power unit (8) and remote operation devices
10 for the hydraulic cylinder are situated at least partly within the piston head
(4) and or the piston rod (5).
2. A hydraulic cylinder (1) comprising a cylinder chamber (6), a piston head (4)
within said cylinder chamber (6) forming two sub chambers (7, 7') of said
cylinder chamber one on each side of the piston head (4), and a piston rod
15 which runs from one side of the piston head (4) through at least one of said
sub chambers (7, 7'), wherein the hydraulic power unit (8) for operation of
the hydraulic cylinder (1) is situated at least partly within the parts forming
the piston head (4) and or the piston rod (5).
3. Hydraulic cylinder or plug according to one of the preceding claims, wherein
20 the piston rod (5) runs through both sub chambers (7, 7').
4. Hydraulic cylinder or plug according to one of the preceding claims, wherein
the piston rod (5) and or the piston head (4) comprises at least partly a
remote controlling device and or the hydraulic power unit (8), comprising at
least motor (10), circuit board (13), valves (12), pressure transmitter (14),
25 hydraulic pump (11), etc, for the hydraulic cylinder (1).
5. Hydraulic cylinder or plug according to one of the preceding claims, wherein
the motor (10) and the hydraulic pump (11) of the hydraulic power unit are
positioned at least partly within the piston rod (5).
6. Hydraulic cylinder or plug according to one of the preceding claims, wherein
30 the piston head (4) comprises feed lines for hydraulic fluid from the first sub
chamber (7), through said valves (12) and said pump (11) to the second sub
chamber (7').
7. Hydraulic cylinder or plug according to one of the preceding claims, wherein
35 the hydraulic cylinder is two-way operational and the hydraulic pump (11) is
a two-way pump.





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INTERNATIONAL SEARCH REPORT

Inte

Application No

PCT/N0200000375

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F16L55/28 F16L55/128 F16L55/132 F15B15/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16L F15B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 158 181 A (EMG-ELTMA HEBEZEUGE OSCHERSLEBEN GMBH) 28 November 2001 (2001-11-28)	2
Y	column 1, line 51 - column 7, line 20; figures 1-7b	1,3,7
Y	WO 03/067134 A (CARSPHAIN LIMITED; EARLY, CIARAN; GAGE, ERIC; MCTAVISH, DOUGLAS; EARL) 14 August 2003 (2003-08-14) page 8, column 13 - page 11, column 9; figures 2-5	1,3,7
A	US 5 029 614 A (LARA ET AL) 9 July 1991 (1991-07-09) column 3, line 3 - column 7, line 59; figures 1-4	1,2,4,5
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

8 March 2005

Date of mailing of the international search report

16/03/2005

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INTERNATIONAL SEARCH REPORT

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Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 6 282 893 B1 (PORTER DON B ET AL) 4 September 2001 (2001-09-04) abstract; figures 1-10 -----</p>	2,4,6,7

INTERNATIONAL SEARCH REPORT

Intern:  Application No
PCT/N020  000375

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 1158181	A	28-11-2001	DE 10026147 A1	06-12-2001
			EP 1158181 A2	28-11-2001
			ES 2165339 T1	16-03-2002
WO 03067134	A	14-08-2003	IE 20020089 A2	20-08-2003
			AU 2003202132 A1	02-09-2003
			BR 0307594 A	01-02-2005
			CA 2475585 A1	14-08-2003
			EP 1476688 A2	17-11-2004
			WO 03067134 A2	14-08-2003
US 5029614	A	09-07-1991	NONE	
US 6282893	B1	04-09-2001	US 2002026792 A1	07-03-2002
			US 2001042435 A1	22-11-2001

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